Chapter 2

Cultural Determinants of Spatial Heterogeneity in Forest Landscapes

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Abstract Forests constitute fundamental parts of our living environment and provide a wide range of important benefits and services to society that go far beyond forest products. From a landscape ecological perspective forests can be approached as part of an overall landscape whose pattern affects ecological processes across dimensions of common time and space. Forest landscapes often consist of complex assemblages of forest and non-forest elements (patches, corridors, and matrix) whose arrangement reflects, in part, the magnitude, intensity, and type of human intervention and disturbance. This chapter describes some of the cultural patterns inherent in selected forest landscapes with examples from southern Italy and southern Ontario, Canada. We outline how cultural determinants, such as land tenure systems, forest tenure regimes, silviculture traditions, management plans and practices can affect the way forest landscapes are spatially-arranged and the intrinsic heterogeneity associated with them. We provide illustrative examples of cultural determinants of spatial heterogeneity and conclude by discussing ways for enhancing functional and cultural attributes of forest and non-forest landscape elements within a landscape ecological perspective.

2.1 Introduction

Since its foundation, landscape ecology has been devoted to solve a number of research questions across the gradient between natural and cultural ecosystems (Risser et al. 1984; Forman and Godron 1986). The concept of landscape itself conveys the idea of something that is not totally natural, but somehow modified by humans for cultural needs. Each landscape includes traces of cultural effects that emerge across regions and scales (Nassauer 1997). Some effects are powerful enough to control landscape patterns. Cultural controls markedly emerge in landscapes that have been modified and shaped for productive reasons, like rural and forest landscapes (Brown

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et al. 2007). This is because the cultural influence on single or multiple ecosystems expands when benefits and commodities are largely tangible and relevant for a given community.

One of the most-evident consequences of this cultural control is the alteration of landscape patterns that, depending on the economic and social relevance of the control, may lead landscapes towards simplified conditions (e.g., landscapes in Iowa, see Corry and Nassauer 2002) or, in some circumstances, diversified and heterogeneous structures (e.g., forested matrix landscapes like in the Mediterranean basin, Fig. 2.1).

In landscape ecology, these myriad possible patterns are described by the term *spatial heterogeneity* which refers to the composition and distribution of patches (i.e., ecosystems) at a given temporal and spatial scale (Forman 1995; Li and Reynolds 1995). Spatial heterogeneity is a reflection of the physical environment, the imprint of past and current land use, and the interaction among these variables (Crow et al. 1999). Landscapes are heterogeneous systems and therefore their study requires a thoughtful understanding of the main causes of spatial variability and the relative consequences for ecological processes (Turner 1989). At the same time cultural effects control and define many landscape patterns and alter ecological processes, while landscape patterns affect local culture (Nassauer 1995). For example, farmers in rolling landscapes change perceptions and attitudes for land stewardship based on suitability of cultivation methods (Nassauer and Westmacott 1987).

Recent studies in landscape ecology reviewed factors that control for landscape patterns and heterogeneity in rural landscapes. For example, Corry and Nassauer (2002), identify three sets of cultural values and traditions that affect the structure and function of rural landscapes in midwestern USA: (a) land division, settlement patterns, and ownership traditions; (b) applied science and technology; and (c) stewardship values and landscape aesthetic values. These values and traditions include things like traditional farm and field size, farm management tools and choices, and norms for caring for the rural landscape, including its appearance.

Fig. 2.1 Complex mosaic of forest and non-forest elements in the Mediterranean region, Apulia Region, southern Italy (photograph by Claudia Cotugno)

Similarly, land tenure systems and forest tenure regimes can be identified as factors controlling for patterns and processes in forest landscapes. For example, Chidumayo (2002) demonstrated how land tenure is responsible for significant structural and functional differences in re-growth following clearing of mature woodland.

Other factors include silviculture traditions and current management plans and practices (e.g., forest harvest and thinning techniques) which are important determinants of cultural patterns and ecological processes variations. These factors contribute to the cultural control of forest landscapes thus acting as drivers of spatial heterogeneity across scales.

In this chapter, we review some of the main determinants of spatial heterogeneity in forest landscapes placing emphasis on the role of humans in shaping patterns and maintaining or altering processes. We stress the concept of forest landscape thus putting it in the broader context of landscape ecology and natural resource management. We provide illustrative examples of cultural determinants of spatial heterogeneity in selected forest landscapes of southern Italy and southern Ontario, Canada. We conclude by discussing ways for enhancing functional and cultural attributes of forest landscapes' components.

2.2 Defining and Understanding Forest Landscapes

Forest landscapes are undoubtedly difficult to define in a general way because they often consist of a mixture between forest and non-forest elements, such as farmlands, roads, water bodies, villages, and different types of vegetation. According to Runesson (2004), forest landscapes can be seen as: *portions of the land that the eye can see in one glance and in which the forest is the most dominant element*. Most forest landscapes are, indeed, land mosaics in which forest management attempts to cope with nature conservation, recreation, water management, and other major societal objectives or multiple uses (Forman 1995). Forest landscapes reflect past and present landscape management activities, and to some degree, the consequences of various types of natural and human disturbances, such as climatic disturbance, fire suppression, and agriculture abandonment (Baker 1993; Boose et al. 2004). In southern Ontario, for example, several different land division systems created a landscape mosaic made by forest patches, crop fields, farmsteads, roads and clustering houses with odd angles, triangular "gores" and an unusual spatial pattern and heterogeneity (Corry et al. 2006; Hart 1998) (Fig. 2.2).

One of the main characteristics of forest landscapes is therefore the presence of forest-type vegetation with patches of various size, shape, and degree of "connectness" (Perera and Baldwin 2000). The structure and spatial arrangement of these patches largely depend on their origin, type and magnitude of human control or natural disturbance of both the forest and surrounding landscape matrix.

Forest patches represent the fundamental elements of these landscapes as they affect many ecological processes, including the movement and persistence of particular species, the susceptibility and spread of disturbances, such as fires or pest

Fig. 2.2 Forest pattern heterogeneity in southern Ontario (photograph by Robert Corry)

outbreaks, and the redistribution of matter and nutrients. In managed landscapes like rural areas, forests are often the most biologically-diverse habitats. Studies of insect outbreaks have shown how the spatial arrangement of forest patches influences the distribution and abundance of organisms (e.g., forest tree leaf-feeding insects) across landscapes, see: Coulson et al. (1999). Complex forest landscape mosaics are considered to provide more locations for different foraging behaviours and for encouraging more boundary-crossing animals through elements of connectivity (Schooley and Wiens 2004).

Other studies have focused on the ecological impacts of management on forest patches and the effects of silvicultural practices on species dynamics (Gustafson and Crow 1994; Michael and Hermy 2002). The most significant impact of forest management is that caused by large-scale clear-cut logging, where forest composition, structure, and function are drastically changed, often for the very long term. This process may lead to forest landscapes made of even-aged patches with an overall reduction in the spatial heterogeneity and landscape functionality. At a finer contextual scale, management may result in multi-aged patches with fine-scale heterogeneous conditions.

2.2.1 Cultural Determinants of Forest Landscapes

The way forest landscapes appear to an observer has to do with many driving or controlling factors that operate simultaneously (Bürgi et al. 2004). As forest landscapes are the results of the interplay between natural disturbances and human interventions, a general perspective is needed. Such perspective provides valuable information on how landscapes are composed and configured and the reasons behind past and current patterns and processes (Brown et al. 2007).

A conceptual model is therefore proposed in order to organize the flow of information and the main cultural factors influencing the spatial heterogeneity of forest

landscapes (Fig. 2.3). The model is an adaptation of the so called **DPSIR** framework: **D**riving forces, **P**ressure, **S**tate, **I**mpact, and **R**esponse (Smeets and Weterings 1999).

The model considers *land tenure systems*, *forest tenure regimes*, *silvicultural traditions*, *management plans and practices* as main cultural drivers or determinants (**D**) of **patterns** and **processes** in forest landscapes. These drivers operate through specific pressures (**P**), such as *land-use change* and *landscape disturbance* which in turn determine a change in the state (**S**) of forest landscapes in terms of cultural patterns and ecological processes. Such changes emerge in a series of subsequent and interrelated impacts (**I**) which include alterations of landscape spatial heterogeneity, forest fragmentation, shape complexity as well as impacts on species diversity and natural successions. A wide range of indicators and spatial measures exist to quantify the magnitude and trend of impact and to inform the response (**R**) of forest planners and mangers in setting long-term sustainable plans and management actions (see: North and Keeton, Chapter 17).

For the practical purpose of this chapter, we define *land tenure system* as the institutional framework which society creates to make land ownership, use and management possible and which reflects the level of development in society, economy and technology (Bruce 1998). A land tenure system is the bundle of rights, rules, regulations, and laws that establish the ownership of, and access to a land property, and protect the pattern of ownership (Saastamoinen and Matero 2004). Land tenure, either private or public, is a socio-cultural sensitive issue and generalization to describe global trends is therefore limited by regional factors and local constraints. In forest landscapes, land tenure is one of the main determinants of spatial heterogeneity of the landscape matrix that is the "medium" in which forest patches are embedded (Lindenmayer and Fischer 2006). Where most of the land is owned by smaller, private landowners as opposed to larger, publicly-owned land, the forest landscape appears parcelized into units or patches whose size and shape are related to ownership and land management units. This condition facilitates forest fragmentation and land-use conversion. Where most land is held by very large landowners, the resulting landscape is composed by larger divisions of land into units, like fields or forest blocks (Corry et al. 2006). Ownership parcelization determines spatial structure, with consequences for biodiversity and forest productivity (Crow et al. 1999). In addition, a large number of landowners with a diversity of interests can result in uncoordinated forest management regimes varying in extent, intensities, and spatial implementations. Using timber harvest models, Gustafson and Loehle (2006) predicted the cumulative effects of ownership parcelization and land divestiture on forest landscapes and found significant effects on most measures of forest fragmentation.

Parcelization and subdivision of property into small units are typical driving forces of spatial heterogeneity in Mediterranean forest landscapes, such as those in southern Italy. The patterns of land division and ownership have commonly fragmented primeval forest ecosystems along lines that coincide with roads network, farm boundaries, and settlements. Cyclical disturbances, such as rotational grazing, cutting and coppicing or fire management (i.e., landscape pressures, P) have gradually led to complex and heterogeneous cultural patterns characterized by relatively

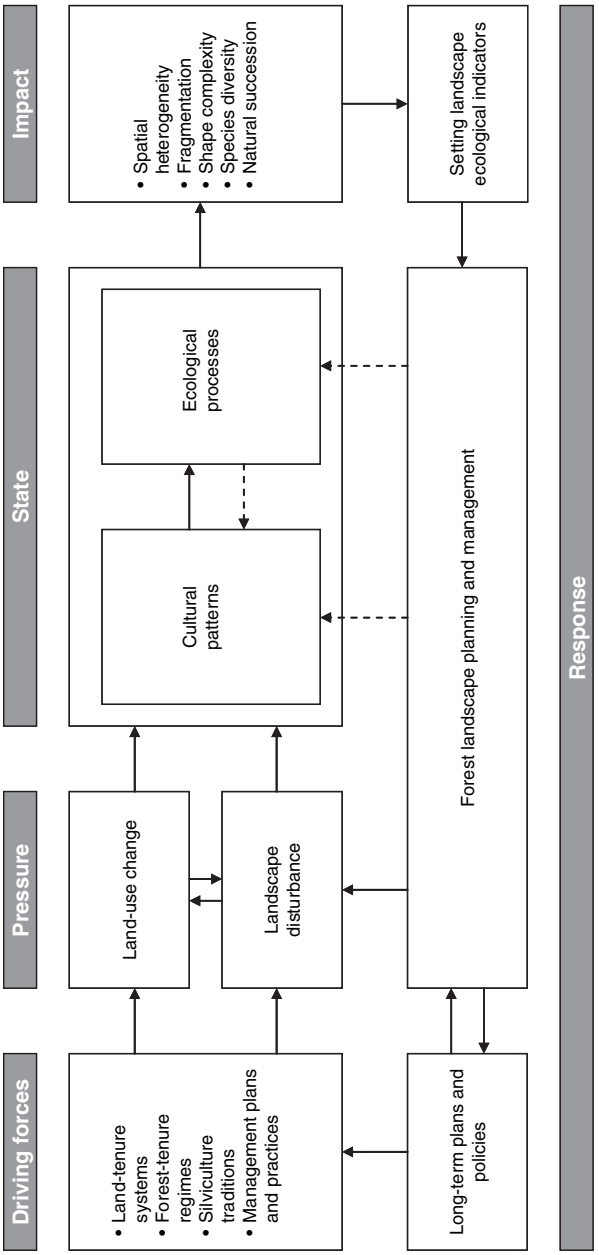

Fig. 2.3 Conceptual model for analyzing the main cultural factors influencing the spatial heterogeneity of forest landscapes

small and regular forest patches. These patterns not only increase spatial heterogeneity in the landscape, they also provide valuable habitat for species that would otherwise disappear or be displaced in the agricultural matrix (Brown et al. 2007).

In southern Ontario forest patches relate to farm and field sizes, and show boundary effects. Since woodlots are sources of fuelwood, construction timber, hunting, trapping, and maple syrup, most farms retain woodlots along back property lines. Farm shapes and layouts affect the shape and alignment of forest patches (see: Fig. 2.2). Farm layout and field sizes in Ontario are generally divisions of five acres (the cultural land division norm, equal to about two hectares), thus common forest patch sizes on Ontario farmland are two, four, six hectares (and so on). Similarly, farm dimensions control forest patch shape, such that a two hectare forest is approximately square, and a four hectare forest is a rectangle with length approximately twice that of the width. Forest patches throughout are small and regular in shape (Pearce 1992; Moss and Strath Davis 1994).

Forest tenure regime is the combination of legally or commonly defined forest ownership rights, responsibilities, and other arrangements for the management and use of forest resources (Romano 2007). Forest tenure directly affects the conduct of forest landowners which in turn affects the way forests are managed and the resulting forest landscape pattern (Gustafson and Crow 1996). In their review, White and Martin (2002) adopt a set of categories to describe global trends in forest tenure and forest ownership rights, starting with the predominant legal categories of public and private ownership (Table 2.1).

Although most forests in the world are in public ownership, trends towards community access and ownership have increased, based on a common view that private ownership may improve economic efficiency and sustainable use of landscapes (FAO 2007). In countries with economies that are in transition, legal transfer of rights to communities or recognition of pre-existing community-based rights have

Table 2.1 Official forest ownership in 24 of the top 30 forest countries

Category	Sub-category	Estimated distribution at global scale	
		Area in $10^6 \times$ ha	Percent of total
Public ownership*	Administered by governments	2,803.20	77
	Reserved for community and indigenous groups	131.40	4
Private ownership**	Owned by indigenous and other local community groups	246.30	7
	Owned by private individuals and firms	443.00	12
Total		3,623.90	100

*All lands owned by central, regional or local governments.
**Rights over a specific area that cannot unilaterally be terminated by a government without some form of due process and compensation (White and Martin 2002).
(see: White and Martin 2002 for more details).

increased in the share of private forests. Securing forest tenure to local communities is indeed a prerequisite to an efficient forest management as it creates common property rights on forest resources (LeMaster and Owubah 2000; FAO 2006). From a landscape ecological perspective, the type of forest tenure regime or ownership may affect the structural pattern of forest patches, thus influencing the degree of spatial heterogeneity of forest landscapes at large. Studies on forest tenure regimes have shown the relationship between different types of ownership and spatial patterns of forest cover (Spies et al. 1994; Turner et al. 1996; Wear et al. 1996). Crow et al. (1999) investigated the main factors affecting spatial heterogeneity in forest landscapes of Northern Wisconsin, USA. Forest ownership and physical environment explained significant portions of the spatial variation in the structure of forest patches (e.g., mean patch size).

Different types of forest characterize forest tenure in southern Italy: privately owned forests are mostly covered by broad-leaved species – such as *Quercus ilex*, *Q. trojana*, and *Q. pubescens* – that are managed through coppicing. Under public ownership rights, high forest systems are more common (INFC 2007). Over the past two-decades, trends towards coppice conversion into high forest have substantially increased especially in situation of large publicly-owned lands. On privately-owned forests, conversion is still limited because the small size of forest patches makes high forest systems not economic feasible (INFC 2007). Conversely, coppicing still represents a source of timber for many rural communities with an important role for the local economy. A number of regulations affect the forest tenure regime in this region, especially in situations where large and continuous forest patches characterise the landscape. In particular, new regulations have been recently proposed to guide the management and conversion of coppice woodlands thus integrating ecological functions (e.g., maintenance of forest ecosystem health, biodiversity conservation), with economic and social purposes (e.g., timber and recreation).

Forest tenure regime is affected in southern Ontario by management by-laws and forest agreements (short-term adjustments to ownership rights in exchange for technical assistance and low-cost reforestation of degraded agricultural lands). Local municipal by-law regulations limit tree cutting on private property. The limits are generally broad, but clear-cutting forest land without a permit is an actionable offense. Selective harvests of forest land and minor changes to size and shape of forest patches can occur incrementally without requiring a permit. Forest by-laws are enacted and enforced at a municipal (local) level and apply generally only to forests larger than two or four hectares (depending on jurisdiction) (Fitzgibbon and Summers 2002). Forest management agreements result in "agreement forests" – patches of forest where reforestation of abandoned, marginal agricultural land was made possible by technical and financial support from provincial government. In exchange, an agreement between land owner and provincial government was signed to protect and manage the forest land. These forests are sized and shaped based on the former field size and in recent history they are dominated by mono- or bi- or tri-culture stands of coniferous trees – such as *Picea glauca*, *Pinus strobus*, and *Pinus resinosa* – in landscapes that are typically deciduous-forest dominated.

Silvicultural traditions are the typical methods employed by local communities and forest managers for harvesting and regenerating forest stands to achieve production of fuelwood, fiber, and other types of products or commodities. Silvicultural traditions are generally based on an array of methods of carrying out the harvesting, regeneration, and stewardship and these methods vary according to the particular species, site conditions, cultural conventions, silvicultural system, and the type of forest in a given geographical region. Traditional methods for managing forest stands and woodlands generally incorporate a sustainable view of the system being managed, because these methods often support the idea of self-regenerating the forest through time with limited use of technologies and external inputs. In addition, these methods are often rooted in the traditional knowledge that communities have of forest and land-use management, thus representing a cultural heritage that is worth preserving (Rotherham 2007). Traditional methods are important cultural determinants of forest landscapes as they represent the inherent capacity of humans to benefit from forest resources without losing the linkage between ecological patterns and processes at landscape level.

In southern Italy a good example of traditional silvicultural method is "coppicing". This method involves cutting back trees periodically at the base of the stumps to produce new shoots regenerating the forest. If a woodland is managed in adequate blocks of rotation coppice, the structure that results could provide desirable ecological conditions for many species adapted to open woodland (e.g., woodland-floor vegetation). Various studies demonstrated how the lack of traditional management, such as overstood coppicing, could negatively affect the response of species to forest patterns, thus limiting the capacity of forest landscapes to support ecological processes (Sanesi et al. 2004; Sanesi et al. 2005). However, the increase in harvesting costs and the high level of parcelization of property is causing the abandonment of many coppice woodlands. Silvicultural techniques are also being drastically simplified in order to reduce costs, thus causing the loss of the wealth of traditional knowledge that has developed around this way of managing forest landscapes (Parrotta and Agnoletti 2007).

In southern Ontario forests, silvicultural traditions range from husbandry of sugar maple trees (*Acer saccharum*) for maple-syrup production, to promoting hardwood species for lumber and softwood species for timber, poles, and pulp. Small, privately-owned remnant woodlots on farms are commonly deciduous species valued for lumber, maple-syrup, or fuel-wood. Agreement forests are commonly held by farm or small private landowners and primarily provide timber, poles, or pulpwood. Selective harvesting is commonly used to favour sugar maples and for fuelwood harvest – beyond that there is not a traditional way of managing the remnant woodlot for products (either timber or others).

Management plans and practices are those strategies and activities commonly employed by forest professionals, forest-land owners, timber industries, or forest authorities to achieve timber production, forest conservation and recreation, or any combination of these (Kangas et al. 2000). Forest management plans are operational plans that provide landscape-level analysis and directions to enable tactical

decisions for management of forest patches within a landscape context (Heiligmann 2002). Plans allow guiding the management of forest resources for long-term stewardship beyond the tenure of current ownership. Management plans could regulate various activities and management practices, such as clear-cut logging, seed-tree, shelterwood, selection harvesting and so on. In clear cutting, all trees are cleared from a forest site or patch and a new, even-aged stand of timber is grown naturally from seeds from the surrounding trees, or artificially from sown seeds or planted seedlings. This system generates even-aged forest patches. With the seed-tree system, an area is generally clearcut, except that a few seed-producing trees are left to naturally regenerate the area and the seed trees are removed after the seedling stand is established. In the shelterwood system, trees are removed in a series of cuts; some trees are left for several years to provide seeds and to protect the seedlings before being removed. The selection harvesting is an uneven-aged management system, resulting in stands with intermingled trees of many ages and a variety of sizes. If not well guided by large-scale ecological plans, management practices may drive severe changes in the spatial heterogeneity of forest landscapes, thus affecting a number of processes, e.g. flora/fauna dispersal, which are sensitive to forest ecological patterns. Using a combination of data from 34 studies, Dunn (2004) analysed the impacts of logging on species diversity of multiple taxa. Overall, logging did not decrease species diversity, however selective harvesting appeared to have much less impact on species than higher intensity and larger-scale management practices (e.g., clear-cut logging).

In southern Italy, management plans and practices follow a number of general rules and regional ordinances which apply mostly to publicly-owned lands. Within this type of ownership, shelterwood cutting is commonly applied on large extension of high forests. In situation of high heterogeneity of environmental variables (e.g., climate, soil and elevation) shelterwood cutting is normally preferred on small extension as this could allow creating mixed patterns of forest patches which facilitate a number of ecological processes related to species occurrence and dispersal. An important aspect of management in this region is the conversion of forest plantations – *Pinus halepensis* and *Pinus pinea* into patches of indigenous forest vegetation. Selective thinning is currently adopted to promote the establishment of native species through secondary successions. Indeed, in managed forests natural regeneration largely depends on the reduction of canopy cover after thinning that increases light availability in the understorey, allowing efficient resource exploitation by seedlings (Malcolm et al. 2001).

In southern Ontario most timber harvest is mechanized and requires access by wheeled or tracked harvest machines, whereas maple-syrup production varies from very fine-scale and horse-drawn sap collection to broad-scale and vacuum-pipeline sap collection. For maple syrup production most forest management activity occurs during a time of frozen soil which lessens the disturbance of forest soils and herbs. Forest harvest occurs throughout the year and can lead to soil compaction and damage to herb and shrub layers. Softwood harvests, especially of the regularly-spaced agreement forest plantings, tend to have regular intervals and patterns associated, such as thinning of selected rows (see Fig. 2.4).

Fig. 2.4 Silvicultural thinning in a spruce plantation, southern Ontario. Photograph shows thinning of every fourth row of plantation and inset shows machine technique for harvest (photograph by Robert Corry)

2.2.2 Cultural Patterns and Ecological Processes

The pressures generated by the driving forces may lead forest landscapes changing their state (*S*). Changes at landscape level are critical as they allow the creation of land mosaics that can be more or less heterogeneous depending on the type and magnitude of the changing (Forman 1995). If we consider forest landscapes as dynamic systems, it is important to evaluate the current status and past changes in terms of cultural patterns and ecological processes (Sanesi et al. 2006; Parrotta and Agnoletti 2007).

Cultural patterns in forest landscapes can be defined as a combination of different forest patches and other land units, whose arrangement follow the way humans have employed land resources within environmental constraints and in relationship with the cultural drivers of spatial heterogeneity and socio-economic context. Cultural patterns are consequences of human management and constitute the underlying structures of forest landscapes. The pervasive effects of land tenure systems, management practices and other cultural drivers gradually convert the intact forest ecosystems to smaller, fewer fragments having more geometrized shapes (mounting fragmentation and change in shape complexity: Impacts, Fig. 2.3). Forest fragments

would not be simplified only under circumstances of unusually-high required effort, exorbitant costs, or technical limits (Corry and Nassauer 2002). A study in Wisconsin (USA) for example noted that forest patch shapes were simpler in disturbed (i.e., managed) forest landscapes containing scattered old-growth fragments and early successional hardwood and conifer forests (Mladenoff et al. 1993).

Ecological processes in forest landscapes are those functions supported or facilitated by cultural patterns and include things like movement and persistence of particular species (e.g., disturbance-specialist species, see: Dunn 2004; Otto 1996), susceptibility and spread of fires (Franklin and Forman 1987) or pest outbreaks (Coulson et al. 1999), and redistribution of matter and nutrients (see: Chao et al., Chapter 16). Haveri and Carey (2000) demonstrated how variable-density thinnings can enhance abundance and diversity of winter birds in second-growth Douglas-fir. Patterns of interspersed forest patches could increase understory and herb layer (i.e., niche diversification) and enhance populations of species associated with shrubs and herbaceous vegetation (see also: Carey 2001). However, the persistence of processes within forest landscapes is a function of the degree of patchiness of cultural patterns (i.e., fragmentation) and of patch-level attributes, such as: size, shape, and core area, which can influence the interaction of forest patches with adjacent patches, corridors, or matrix (see: Saura et al., Chapter 10). Large forest patches with irregular shapes are considered to provide more interior locations for specialist species (Bogaert et al. 2001) and to encourage more boundary-crossing animals through coves and lobes (Dramstad et al. 1996) than small and regular patches (typical of cultural driven landscapes). In addition, complex shapes lead to microclimatic variability and greater plant diversity along edges (Forman 1995). In highly-fragmented forest landscapes, patch sizes and shapes have been shown to have a relationship under particular management conditions (Corry et al. 2006). In southern Italy, for example, a recent study tested a number of models to predict the variation of forest patch shape and other landscapes metrics in relation to forest vegetation type, terrain slope, and distance from other land-cover types (Lafortezza et al. in prep.): indigenous forest patches (i.e., sclerophyllous forests) showed more irregularly shapes than coniferous forest or broad-leaved coppiced woodlands, especially in areas characterized by steep slopes or located at furthers distance from agricultural and urbanized areas.

2.3 Enhancing Cultural and Ecological Attributes

Cultural patterns and ecological processes are critical to form and function of forest landscapes because of the resilience, longevity and dominance associated with these factors. In many forest landscapes a delicate ecological balance has been maintained over centuries despite human exploitation and disturbance (Naveh 1995; Vos and Meekes 1999). Continuing changes to the socio-economic template may drive the transition of cultural patterns in terms of composition and configuration and this could limit a number of processes that depend on disturbances.

Human-induced changes could be beneficial or detrimental to forest landscapes, depending on the ecological consequences of management plans and interventions. Specific concerns, like maintenance of critical key wildlife habitat patches need to be addressed in current strategies of sustainable forest landscape management (Dunn 2004).

The goal of promoting a multiple use of forests cannot be achieved without considering forests within a landscape ecological context. Following this perspective, landscape ecology may be assumed to be a fundamental approach for integrating cultural patterns and ecological processes in a unique framework. Forest patches as any other landscape components need to be understood as spatial units having a combination of "vertical" natural elements modified by human interaction. Such units also have "horizontal" interactions with their surrounding habitats that contribute to the biodiversity and the ecological functionality of the rural landscape at large. Forest patches need to be analysed at the regional scale in order to understand their spatial arrangement and the spatial placement of neighbouring patches and corridors such as, wetlands, hedgerows, and other woodlands. Forest patch management needs to consider the temporal and spatial character of managed disturbance for multi-phase forest conditions. This may aid understanding of spatially-explicit processes like fragmentation and loss of species diversity that have reached substantial levels of concern in many forest landscapes, such as those in southern Italy and southern Ontario. In addition, forests have to be considered as part of the "cultural" heritage of the specific region while helping to sustain the production of multiple goods and services that enhance the livelihood security, quality of life and wellbeing (Parrotta and Agnoletti 2007). The use of and interaction with forests is part of reciprocal human-landscape interactions. Therefore forest management and conservation should be undertaken by local and regional authorities through the implementation of suitable policies and planning strategies (see: Azevedo, Chapter 14).

The cultural pedigrees of Italian and Ontario landscapes are markedly distinct and of very different ages. Though the resulting patterns differ, these examples of forest landscapes share similar constraints and potential: (1) complex land use patterns made by forest patches of relatively small dimension and regular shape that are controlled by forest and non-forest land uses; (2) high variability of landform units; (3) persistence of vernacular identities and uses in local rural-communities; (4) prospects of new "ancillary" functions of woodlands (e.g., greening the surrounding urban areas; carbon sequestration). Considering these factors, it is critical that management strategies are based on the characteristics of these cultural landscapes, thus avoiding uniform intervention over large surface areas. Spatial units of woodlands have to be differentiated in both their vertical and horizontal structures by allowing the presence, within the same patch, of trees that vary in species, age, height, stem diameter, crown development, and ecological niche. The collective integration of these principles may help to achieve a more sustainable mosaic of forest patches within cultural landscapes that is highly conducive to promoting biodiversity and other important ecological processes.

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